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THE FARM POWER PROBLEM.¹

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There are millions of horses and mules, hundreds of thousands of gas tractors, a great number of steam traction engines, and some millions of small gasoline and kerosene engines in use on our farms. The engines of farm-owned automobiles and motor trucks generate an untold number of horse-power hours each year. Windmills and water power are used in almost numberless cases, and still many farm operations are done entirely by hand.

We know that the use of labor-saving machinery has played a very important part in making American farmers the most prosperous in the world. And the use of labor-saving machinery nearly always means the substitution of some other form of power for man power. The fundamental problem is to determine just where it is economical and practical to substitute some other form of power for man power, and just what other form of power and size of power units should be used.

More power is required to carry on the work of growing and harvesting our crops and transporting produce to market than for any other class of work on the farm, and it is the question of what are the best sources of power for this work which is attracting the most attention today.

Until a very few years ago the horse and the mule furnished practically all the power for that part of this work which was not done by hand, but now the tractor, the motor truck and the motor cultivator have become serious competitors for certain parts of this work.

We do not know how many farmers are using tractors but the number sold by manufacturers in this country in recent years gives an idea of how their use has increased. In 1916, 28,000 were sold; in 1917, 50,000; 1918, 96,000; in 1919, 136,000. Of course, the farms where tractors are now being used constitute only a comparatively small percentage of the total, but in some sections the owner-

¹ Paper read at the eleventh annual meeting of the American Farm Economic Association, December 30, 1920.

ship of one of these machines is the rule rather than the exception among farmers.

Some of the questions in which the investigator is interested are: Are tractors profitable machines for the men who are already using them? Are they being used to the best advantage? If not, how can the efficiency of the farm be increased through their use? Should these farmers be advised to purchase other machines when their present ones lose their usefulness? What other farmers, if any, should be advised to purchase tractors?

At the beginning, I think, we must admit that the tractor is no longer an experiment. To be sure, improvements will be made in the future—many of them, but the tractors which are now available have been tried by thousands of practical farmers and pronounced successful by a great majority of them. Of course, many tractors have been tried in the past on farms where they could not be used economically and by men who were not capable of operating them efficiently, and we must expect similar occurrences in the future. But such information as we now have warrants us in laying down as one of the major premises for any unbiased investigations that the right tractor in the hands of a competent operator on a farm adapted to its use, can be used advantageously and economically. Another equally important premise is that the mechanical power units which are available today are such that very few of the farms in the country can be operated economically without the use of horses or mules. At present, then, the question is: On what farms should the work be done entirely with animal power, and on which ones should it be done partly with animal and partly with mechanical power?

To answer this question we must know first the power requirements of farms of different types and sizes, as they are now operated. And in obtaining information on this point we must remember that in doing so, we are, in a large measure, simply educating ourselves, for practically every farmer can tell how much power it takes—how many horse-days or tractor-hours—to do the different jobs on his farm.

The farmer does not know, however, and we do not know, just what amount of power can be used most profitably on a particular farm. Take plowing as an example: We often hear the statement that the tractor enables the farmer to do deeper and better plowing than he can do with horses. Necessarily, deeper plowing means more power, and greater cost. But, does any one know how much an increase of from 4 to 6 inches or from 6 to 8 inches in the depth of

plowing is worth in increased yields of different crops, on different soils, under different climatic conditions? Or does any one know just what is the best practice in preparing the seed bed after plowing and just what amount of work on it will yield the greatest net returns?

In the Great Plains area deep plowing and subsoiling have been widely advocated as a means of increasing crop yields, but a series of tests extending over several years on the experimental farms of the Bureau of Plant Industry indicated that for some crops, at least, these practices in themselves have very little effect on yields, and that under the conditions which prevailed at that time the cheapest methods of plowing and preparing the seed bed usually resulted in the greatest net returns.

The cost of the power on farms as they are now operated must also be ascertained. Before we can say whether the introduction of mechanical power will be profitable we must know the cost of the animal power used on a farm, the most economical way of obtaining it, and just how many work-stock should be kept for the greatest profit.

There is no doubt but that profitable changes in horse-management can be made on a great many farms, and the possibilities in this direction must be considered as well as the possibilities of the introduction of mechanical power. We need to know what type of animal is best suited for different kinds of farm work, and to what extent it will be possible to reduce the cost of power as generated by horses.

A considerable amount of data on the cost of keeping work-stock and the cost per day or per hour of work is now available, but the important thing is to determine how these costs can be reduced and the farm profits increased thereby. We know that horses on one farm today sometimes receive twice as much feed per year as do horses of the same general type doing about the same amount of work on a neighboring farm. There is also a wide variation in the number of days or hours of work done per year by horses on different farms.

During the past few years the low price of horses has caused a great many farmers to decide that the raising of colts is not a profitable enterprise.

In the course of a recent farm power investigation made by the Federal Department of Agriculture it was found that on nearly 75 percent of over 300 farms in Ohio, Indiana and Illinois, there were no 1920 colts. There were 2,000 horses and mules on these farms and only 120 colts less than one year of age. Obviously a great many of these farmers are of the opinion that it will be more profitable to buy horses as they are needed than to raise them. We should know

something as to where it will be profitable to raise horses or mules for replacement, and where any needed work-stock should be purchased.

Another important question to which we need a definite answer is: Under what conditions, and for what operations, would it be practical to increase the size of the team, so as to enable one man to control a larger amount of power? In some parts of the country, no matter how many horses there are on the place, or how many are being used simultaneously, the size of the team is always limited to two or three horses. In other sections a team, consisting of four, six or even more horses, is the common unit for heavy field work. Has years of experience led to the adoption of the most practical size of team in every case? Or with the proper hitches can the size of the team be increased to a point where the driver would control as much or more power, than does the operator of a tractor? We must have answers to these questions before we can say with certainty whether men with need of large units for field work should turn to mechanical power.

But let us assume that we have a farm organized and operated for the greatest profit where animals furnish all the power for field work. What will be the effect of the introduction of a tractor on that farm? Obviously the tractor will not be profitable if the same acreages of the same crops are raised, if they are tended in the same way, if the same number of horses are kept at the same cost, and if the same amount of man labor is used as before.

A study of the experience of farmers who are using tractors shows that the introduction of a tractor does not in itself often result in any radical changes in the cropping system. Too many factors, other than the power factor must be considered in deciding on the cropping system. However, since the tractor usually enables the farmer to do a greater amount of work in a given time than he can do with horses, its use sometimes makes possible the planting of crops at a better time and thus results in increased yields. Tractors have also helped many men in increasing the size of their farms, and farm management studies have shown repeatedly that, other things being equal, the larger the farm the greater is the income from it. Of course, every one cannot enlarge his farm at will, but the man who is desirous of farming a larger acreage may find that a tractor will furnish the additional power needed and at the same time do away with the necessity of providing additional man labor. Where the acreage is not increased the use of a tractor generally lessens the amount of

man labor required to operate the farm. This sometimes means a decrease in the expense for hired help. In most cases the number of work-stock is also reduced, but it is not often that enough work-stock are disposed of to pay for the tractor. A certain proportion of tractor owners also say that since the tractor does a large part of the heavy work it is not necessary to give the horses which they still keep as much feed as before. Others say that the cost per horse is as great as before the purchase of the tractor.

We must not forget that the tractor is also an efficient power unit for most kinds of heavy belt work. A recent survey in the corn-belt showed that two thirds of about 300 tractor owners visited use their machines for some belt work. A considerable percentage also increase their incomes by doing custom work with their tractors.

We also know, in a general way, how great the depreciation is on the tractors which are now in use, the amount of fuel and oil required by different tractors for different operations, the costs of keeping them in repair, and the amount of work which they do per day or per hour. But we do not have nearly enough information to enable us to determine the exact place which the tractor should occupy.

The size and type of tractor most suitable for a given farm must be considered in connection with all these questions. It is almost if not quite as difficult to determine this point as it is to determine whether or not *any* tractor will prove profitable. The farmer must choose between the wheeled and the track-laying types, he must decide whether his tractor shall be capable of pulling one plow or ten, whether it shall weigh 2,500 pounds or 25,000, whether it shall burn gasoline or kerosene. In fact he must choose one of nearly 200 models which are on the market today, and the investigator is called upon to answer the question "What tractor is most suitable for my conditions?" fully as often as "Would a tractor be profitable on my farm?" An intimate knowledge of each of the models available is necessary to answer this question. The details of construction must be known, the amount of power the tractor will develop—both on the drawbar and on the belt—the amount of fuel required, the adaptability of the tractor to different kinds of work, and the quality of its work.

We should also be able to say for just what operations it will be more economical to use the tractor and for what operations horses should still be used. A large majority of present tractor owners do the bulk of their plowing with them, and on some farms tractors may be profitable even if used for no work except plowing. But there are a number of other operations for which the use of the tractor may

be questionable. For instance: Disking and other heavy work in preparing the seed bed after plowing require a large amount of power, but in some seasons a heavy tractor will pack certain soils seriously, and on this account many tractor owners still do all this work with horses. Investigations to determine how seriously tractors of different weights and designs will pack soils of different types under different conditions would assist materially in determining the size and type best suited to particular farms. Even though the farmer knows that the use of his tractor for such work will result in a loss in unfavorable seasons, he has the choice of using the tractor every year and accepting this loss in the exceptional years, or of always keeping horses, men and machines available for doing the work if the season is unfavorable for the tractor. There are similar problems in connection with the use of tractors for many other operations.

Other points on which we particularly need further information—as definite as it is possible to obtain—are the reliability of tractors and the cost of operating them. To this end a good number of representative tractor owners should keep complete and accurate records of the work which they do, the time required for doing different kinds of work, the fuel and oil consumed, the cost of repairs, the amount and value of the time lost on account of breakage and trouble. If every state college and experiment station could obtain the coöperation of 50 or even 25 farmers who would keep accurate records regarding their machines, paying particular attention to those points on which it is difficult and sometimes impossible to get information by the survey method or the questionnaire, in a year we would know a great deal more about the reliability of tractors of different kinds, the cost of operating them, and their adaptability to different kinds of work.

A large part of farm work is done with either one or two horses as the power unit. Taking the country as a whole, more than half the time farm horses are used is doubtless spent in one or two horse units. The tractor capable of pulling two or more plows, and developing eight or more horse-power on the drawbar can not ordinarily compete with horses in work of this kind. The motor truck, the small garden tractor, and the motor cultivator, however, are mechanical power units designed especially for such work.

The "Garden Tractor" is capable of doing approximately as much work as one or two horses, and is usually equipped for light belt work. These small machines do not have the advantage of saving

man labor, which the larger tractors have, but they are adaptable to many different kinds of work, and undoubtedly there are farms on which they can be used economically. A very considerable number are now in use, and there is a persistent demand for unbiased information concerning them. Practically no investigational work has as yet been done, however. Neither do we have anywhere near enough information concerning motor cultivators to enable us to say on what farms they can be used profitably.

An investigation made through the crop reporters of the Bureau of Crop Estimates about a year ago showed that at that time there were at least 50,000 farm-owned motor trucks in the country, and that a great many more not owned by farmers were being used primarily for transporting farm products to market and carrying supplies to the farm, doing work which in part at least was formerly done by farm horses.

A study of reports from over 1,500 of these farmer truck owners in the Eastern States and in the Corn Belt showed that most of them are operating farms which are larger than the average, and which are at considerable distances from market. Experience has led most of these men to believe that the biggest advantage of a truck is in saving time rather than in reducing expense. As compared with horses and wagons the trucks save from one half to three fourths of the time required for hauling to and from these farms. A majority of the men still use their horses for some road hauling, and on over half the farms the trucks are not used at all for hauling in the fields and around the buildings. The investigations brought out many other facts with regard to the present status of farm-owned motor trucks, and made available considerable information which should be of value to other farmers who are considering the purchase of trucks. But a great deal more investigational work is necessary before we can say definitely just what farmers can own motor trucks profitably, what size and kind will be best suited to a particular farm, and for just what work it should be used. We must know more definitely the amount of hauling both on the road and on the farm itself for farms of different types and sizes and just how much the ability to get produce to market in a shorter time or to a better market than could be reached with horses and wagons is worth. We must have more definite information concerning the effect of different kinds of roads on the use of trucks, the adaptability of trucks of different types and sizes to the hauling of different materials both on the road and on the farm, the cost of operating them, the possibilities of hiring

a truck or of patronizing regularly established truck routes, and on numerous other points.

We must not consider that our task would be completed if we knew on just what farms mechanical power units can be used profitably under present conditions, which size and type will be most profitable for a particular farm and for just what operations it should be used. The man who buys a tractor or a motor truck this year will expect to be using it five years hence. Will the cost of operating it then be the same as it is today? Or will the comparative costs of doing work with it and with horses be the same as they are today? Five years ago, a gallon of gasoline cost about 12 cents and a gallon of kerosene 6 or 7 cents. Corn was worth 65 cents a bushel and oats about 35 cents. Now gasoline and kerosene are considerably higher and corn and oats are not worth any more than they were then. What will be the ratio in 1925 or 1930?

The U. S. Bureau of Mines says that at the present rate of consumption all our visible reserves of petroleum will be exhausted within 20 years, unless more efficient methods of recovery can be found. This indicates a continued high price for gasoline and kerosene. Will the prices of farm products, and especially oats, corn and hay, stay at their present level? Will farm labor become cheaper and more plentiful, and thus make the saving in man-labor, which to date has been one of the biggest advantages of mechanical power, a less important consideration?

Furthermore, we must always be expecting the development of new and more efficient mechanical power units. The tractor of today is a great deal more efficient and adaptable to a much wider range of conditions than was the tractor of ten years ago, and it is not only possible, but very probable, that there will be further improvements in mechanical power units during the coming decade. Many of the manufacturers maintain well-equipped experimental shops and employ a number of men who do nothing but build experimental machines and try out various changes and refinements of existing models, solely with the aim of making more efficient power units for use on farms. A visit to one of these shops will certainly convince any one that further improvements in mechanical power units are to be expected.

We need to know, then, the power requirements of farms as they are now organized, and as they should be organized for the greatest profit; the possibilities, limitations and cost of all the forms of power now available; and the improvements which we can expect in the future, both in animal and mechanical power.

The U. S. Department of Agriculture and all the state colleges and experiment stations have done what they could with limited funds and personnel to keep in touch with the new developments in the farm power field, and to collect and disseminate information which will aid individual farmers in determining the best forms of power for their conditions, but we all know that the importance of the problem is such that it demands a great deal more study and investigation than has been done to date. Part of the problem belongs to the farm economist, part to the animal husbandman and part to the agricultural engineer, and coöperation among all three classes is desirable in studying certain phases of the problem.

We cannot ever hope to settle the question forever and conditions are changing so rapidly, that statements, especially with regard to the relative profitableness of the different forms of power, which are true today, may be far in error five years hence. It is essential, then, that we concentrate our efforts on those phases of the problem which seem most urgent and concerning which we can expect to obtain reliable results in a reasonably short time.

If they are to have any value other than a historical one, the results of any investigation must be studied and the important points brought out must be made public before conditions have so changed as to make them inapplicable, and we must never forget that, if any investigations are to be worth the money it costs to make them, the results must be accurate and any conclusions drawn must be sound.